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Image bit depth plane digital watermarking for secured classified image data transmission

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Abstract

The demand for rapid use of Internet has increased many folds in distributed environments. It is easy for the custodian of the digital data to transfer images of classification across computers via internet. The information transmitted is not secured. Conventional encryption and decryption algorithms are vulnerable from the thefts of the digital data and do not protect the data from copying after the data is transmitted. The data prone to copyright thefts should be protected against manipulation, misuse and security breaks. First the image is classified using maximum likelihood classification and fuzzy model. Second, for transmission, with copyright information, image is secured, by image bit depth plane digital image watermarking. In this method, image is read and separated into n-bit planes. The accuracy is tested using visual interpretation and assessment. The application of this method is identification of ownership, claim of ownership, online transaction, digital content authorization, file reconstruction. This method is robust against intentional and unintentional attacks of malicious users.

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Keywords: Information security;Data security Image processing; Fuzzy classification; Bit plane;Watermarking;

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1. Introduction

Now a days digital watermarking (visible and invisible)[34, 36]is in current research of information security, for addition of imperceptible information, such as hidden[26]author or copyright[3], logo information. Watermarking could also be used in multimedia[11, 14]. In digital data watermarking the content of the data is inserted as a signal without affecting the visual quality of the image for data security[16]. In digital watermarking, where the information is hidden, as watermark in various kinds of digital medias[18, 28], is termed as cover work[1, 5]. But the hidden[26, 13]information cannot be extracted by the malpractitioners easily by any negative means. Its major application is digital database content intellectual property rights. It cannot be authenticated[9] by the third party or agency, department[30]. But some Hidden visible watermarks[33, 35], most invisible watermarks areHidden. Secure spread spectrum watermarking is described for multimedia watermarking[37]; encryption algorithm is elaborated for target image classification based on the biological features[39]. For information security and access control robust biometric image watermarking finger print and face template protection is explained[40]. The quality of the image could be assessed by error visibility to structural similarity[42]. In Spatial Domain Watermarking method the Least Significant Bit (LSB) image, replaces the least significant bits of pixels selected to embed the information[43]. Feature extraction[20] and Classification, of the digital images possesses current features on the earth. In the fuzzy based classification feature is assigned to a class which has highest degree of membership. Automatic fuzzy clustering using modified differential evolution can be used for image classification[4]. Another Ensemble method for spectral-spatial classification of urban areas is using hyperspectral data[6]. A multiresolution modelling approach can be used for semi-automatic extraction of streets for mapping of urban areas[10, 12]. A fuzzy clustering based segmentation system is used as a support to diagnosis in medical imaging[8]. Efficient fuzzy clustering can be used for multispectral images[18]; extensive research is going on in the field of fuzzy classification, to solve various problems of classifications. Fuzziness is being used as theory in solving the problems of fuzzy classification.Fuzzy classification is used in various applications such as land use classification, hydro geomorphology, image classification, temperature setting etc.

The output needs to be secured before it is transmitted on the digital media. The Bit plane Digital Invisible watermarking is used here to protect the classified image output[7]. This data contains government data for planning. In Digital watermarking the classified image and the watermark image is embedded to form coded image. The new image with watermark is used for transition from source to the destination location via digital media. General users of the image do not know that the image is watermarked or not. In protected format, the image is transmitted from one location to another.

1.1. Requirement for Classification

Table 1. Details of training data imagery

Image	Classification image	Classified o/p image	Watermark image
Bands	4 (R,.G,,B, NIR)	3 (R.G,B)	3 (R,G,B)
Size	2.35 MB	29.5 KB	25.5 KB
Width	113 Pixel	113 Pixel	113 Pixel
Height	113 Pixel	113 Pixel	113 Pixel
Data type	8 bit	8 bit	8 bit
Format:	'png'	'png'	'png'

1.2. Methodology of secured watermarking and classification algorithm

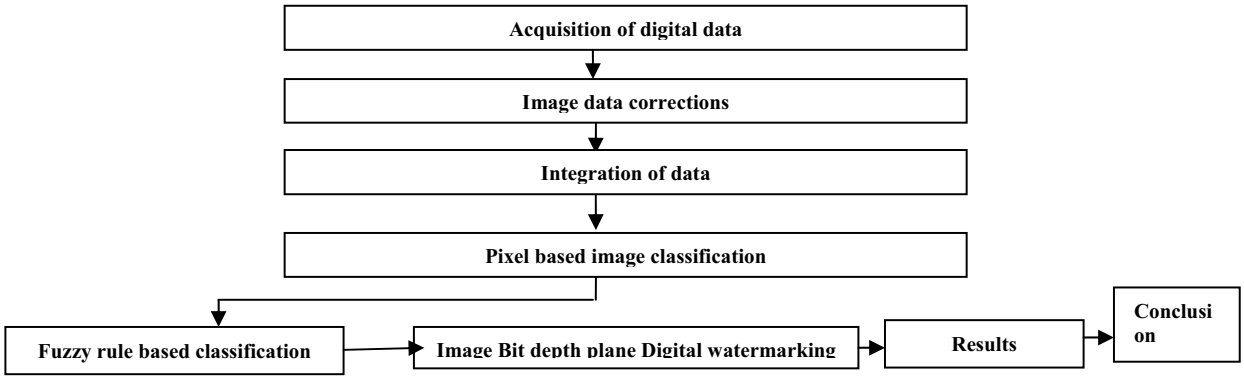


Fig. 1. Flow chart of Methodology of secured watermarking and classification

2. Methodology

- Acquisition of Input digital image: Input image is acquired for testing and experiments, is of high resolution image for classification of streets. For Digital watermarking classified output image is converted to gray scale. Single band is also can be extracted for using as input image in digital watermarking algorithm.
- Image data corrections: it involves enhancement of image by radiometric corrections. Radiometric correction involves removal of atmospheric and color corrections such as brightness and contrast etc.
- Integration of Data: The data is converted to gray scale. The single band from the image is also extracted.
- Classification of Image: For classification Maximum likelihood and fuzzy is used. Classes arehighway, street road, clay roads, built-up, vegetation andcanal. The output image is required to be converted to *.tiff,*.png,*.jpeg format.
- Fuzzy Inference system: The outputs use Gaussian function for membership function definition.Mean and standard deviation is used for defining Gaussian membership function.
- Result: The ML and Fuzzy classification generates the classified image with the feature class Highway, Street roads, clay roads, Vegetation, Canal as shown in figure 4 below.

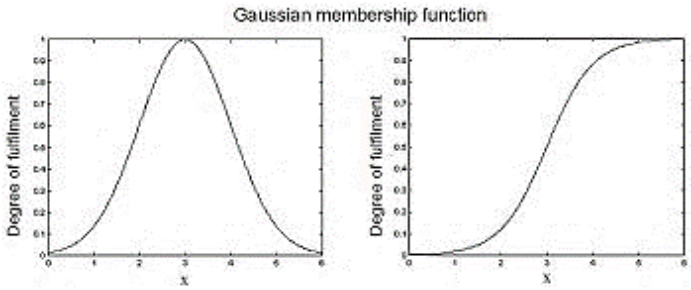


Fig. 2. Membership functions as input to Fuzzy Inference system.

- Image bit depth plane digital watermarking:A Classified image is embedded with the digital watermark Fig (b) using n-last bit plane of both the images. Image is of 8 bit depth. From the depth planes of both images last bit planes are replaced with the first bit planes of the original image. In this method lowest bit plane is considered for replacing.

3. Implementation steps

3.1. Training samples images and classification algorithm

In pixel based algorithm classes are mapped and it is a process in digital cartography [32].

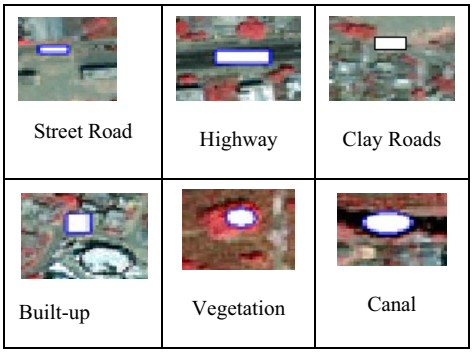


Fig. 3.Training samples images for class Street, Highway, Clay roads courtesy: MRSAC

Table 2. Results of classification

Algorithm	***Highway (%)***	***Street(%)***	***Clay Road (%)***	***Builtup (%)***	***Vegetation (%)***	***Canal (%)***
ML(%)pixels	16.52	32.79	14.43	17.1	12.45	1.26
Fuzzy based(%) pixels	19.9	34.65	17.53	15.85	13.48	1.24
Difference(%)pixels	3.38	1.86	3.10	1.25	1.03	0.02

The training samples for highway, street road, clay roads, built-up, vegetation and Highway, Street roads, clay roads, Vegetation, Canal. Minimum, Maximum, standard deviation, mean are shown in statistics table. Error matrix can be generated to find the actual classified pixels and the original pixels. The classified out is displayed in figure 4 below. The white color shows the built-up areas. The black color shows the canal and river. The greyish color shows the street roads and smaller roads in width than the larger roads. The light grey color shows the vegetation in the urban areas.

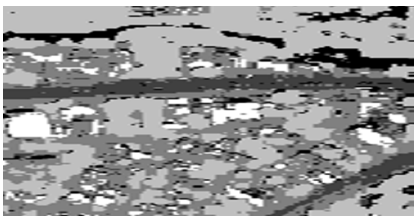


Fig. 4. Result of classification

3.2. *Algorithm for process of classification and rule definition:*In the above classification for clay road, built-up, vegetation, canal rule are defined.

- Create membership functions (f) for each class.
- Membership function is Gaussian as it uses mean and standard deviation for normalised distribution.
- The names of the model and names of the membership functions are given.
- For each class the Red, Green, NIR membership functions are assigned.
- The bands are assigned rule as Red= f1, Green=f2, Nir=f3 output= Street roads.
- Similarly Bands are assigned for other classes.
- The surface view is generated.

The output variable (Highway, Street,Clay road, Built-up, Vegetation, Canal). Table 2 shows the statistics of % of classified pixels.

3.3. Bit depth Plane Digital watermarking : Algorithm for implementation of Digital watermark in classified image.

- Covert Input image to Gray scale or extract one band if it is color image.
- Covert Input watermark image to Gray scale or extract one band if it is color image.
- Separate Original Input image into "n" distinct bit planes where "n" is number of planes.
- Separate Input watermark image into n distinct planes where "n" is number of planes.
- Find out the least significant bit image and most significant bit image in original classified image. Consider the lowest bit plane which when embedded, is extracted from the output image without much distortion in the quality.
- Find out the most significant bits and least significant bit image in the watermark image.
- Finally reconstruct the original image by replacing the last image bit plane to the top most bit plane of original image.
- Extract Watermark from the reconstructed image.

In this method original image is separated into 8 numbers of bit planes. Out of these bit planes, in the most significant bit plane location the data is more clear. The original content starts reducing from the most to the least significant bits. Similarly, watermark image is separated into 8 bit planes.
Least significant bits plane of the original image is replaced with the most significant bit plane of the watermark image. After the replacement of the planes is done than the image is reconstructed to see the original image hidden with the watermark. These bit planes could be replaced with another sequence of data. When the original image is reconstructed after that the watermark also remains intact into the original image. These watermarks cannot be seen by the viewer. The output imagewith watermark does not change the content when compared to the original image without watermark. Figure 6(c),7(c),and 8(c) shows invisible watermarked image.The watermarked output image is almost similar to the original image with hidden information [http://en.wikipedia.org/wiki] which retains the contents.The third party agency cannot crop the watermark as it is possible in visible watermarking. Watermark which are invisible cannot be attacked as it is much robust than the visible image of watermark. The quality and identity of the image does not show much difference. It has more information security and safety[22].

4. Result & Analysis

Fig.5(a)Input remote sensing image

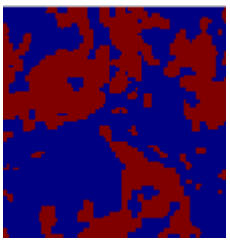


Fig. 5(b) Classified output image

In figure 5(a), 5(b) the input remote sensing image is classified and final output is shown in 5(b). The Extracted image shows the watermark by visual assessment and interpretation which was embedded into the original image. The quality of the watermark is slightly degraded which does not have importance. The similarity between the original and extracted watermark plays a vital role in identifying whether the output generated is original or not. Figure 6(a), 7(a), 8(a) image is watermarked with Figure 6(b), 7(b), 8(b) and final image with watermark embedded is shown in figure 6(c), 7(c), 8(c) with the extracted watermark from the reconstructed image in figure 6(d), 7(d), 8(d). From result of classification in table 2. Fuzzy shows 19.9% of pixel in highway class, 34.65 % for streets, and 17.53 % for clay roads. There is an increase in clay roads and highway pixels due to separation of pixels into appropriate class. The DN values counts are taken into consideration for street features and compared to original pixels in the image for sample feature. The Table 3 shows percentage of pixels.Second, for checking the accuracy of the extracted images of the original and the watermarked image equation (1) is given.

$$Sim\ (X^{*}.X) = \frac{X^{*}.X}{\sqrt{X^{*}.X^{*}}} \qquad (1)$$

In eq. (1) above "X" for Input image and "X*" Image extracted [33, 35].A suitable value of threshold can be set to detect the original watermark. The extracted message similarity is checked with 100 random watermark images including the original with the above formula and also with the visual assessment and interpretation.

Table 3. Percentage of pixels

Method	Classified pixels (%)	Misclassified pixels (%)	Total (%)
ML	78	22	78
Fuzzy	79	21	79

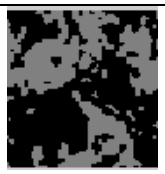


Fig. 6(a). Classified Input Image

Fig. 6(b). Watermark Input Image

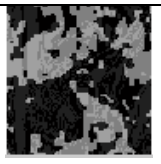
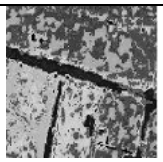
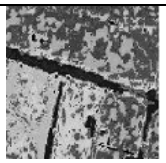
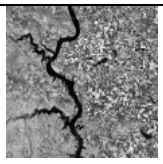
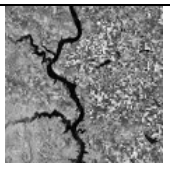


Fig. 6(c). Result of Reconstructed Image

Fig. 6(d). Extracted Watermark from Reconstructed Image.

 Fig. 7(a). Classified Input Image	 Fig. 7(b). Watermark Input Image	 Fig. 7(c). Result of Reconstructed Image	 Fig. 7(d). Extracted Watermarkfrom Reconstructed Image.
 Fig. 8(a). Classified Input Image	 Fig. 8(b). Watermark Input Image	 Fig.8(c).Result of Reconstructed Image	 Fig.8(d).Extracted watermark from Reconstructed Image

5. **Conclusion**

From the above results, it is concluded that the data ownership security, of street image of classification, using Image bit depth plane digital image watermarking, is robust technique compared to other techniques of the image data security. This method is tested with traditional methods of encryption, decryption and cryptography, steganography. This method could be useful to many applications of image classification and data security. Fuzzy inference system (FIS) model can be used for evaluation of number of pixels. The classification image requires covering larger areas such that the Gaussian function takes into account of all the pixels range to select particular feature. For data security, digital watermarkingusing bit depth plane technique can be satisfactorily used for transmission of classified image into land feature classes in remote sensing image. This method maintains the originality of the image as long as it is on the internet. The originality of the data is maintained is considered when it is used by third party agency. This method could be tested on various outputs of the street image classification of high resolution images with several data formats.The size of both the images required to be same size. Can work on different File sizes and for color images.

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